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EXAMINER
SONG, MATTHEW J

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 05/27/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/937,272	AZAMI ET AL.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 March 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-14* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Priority

1. Acknowledgment is made of applicant's claim for foreign priority based on an application filed in Japan on 3/24/1999. It is noted, however, that applicant has not filed a certified copy of the 79250/1999 application as required by 35 U.S.C. 119(b).

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1-9 and 11-13 are rejected under 35 U.S.C. 102(b) as being anticipated by Huang et al (US 5,524,574).

Huang et al discloses a single crystal pulled from a Sb-doped Si melt (col 4, ln 40-67) and the oxygen concentration of a Si single crystal pulled up from a Si melt (i.e. claim 3) depends on the diffusion of oxygen from the surface of the melt. Huang et al also discloses the diffusion of oxygen from the melt to the atmosphere can be controlled by the pressure of the atmosphere, this reads on applicant's controlling one specific element in the atmosphere (col 5, ln 5-67). Huang et al also discloses a single crystal obtained from a melt has a higher oxygen concentration when a pressure is held at a higher value, the diffusion of oxygen to the atmosphere is suppressed so that the upper layer of the melt is maintained at a higher oxygen concentration and vice versa for a lower pressure. Huang et al also discloses the oxygen concentration of a single crystal to be

pulled from a melt can be adjusted at a predetermined value by controlling the atmospheric pressure (col 6, ln 1-67). Huang et al also discloses argon as an atmospheric gas for the growth of a single crystal and an oxygen sensor **17** serving as a detector for detecting the partial pressure of oxygen in an internal atmosphere, which is inputted to a control unit **18** (col 7, ln 1-67). Huang et al also discloses a melt surface in an opening of a crucible (Fig 1). Huang et al also discloses a single crystal pulled from a Czochralski melt has a very high oxygen concentration and oxygen concentration in the upper layer of the melt is controlled by changing the atmospheric conditions (col 15, ln 1-45). Huang et al also discloses an equation relating the partial pressure of oxygen and the oxygen concentration in the upper layer of the melt (Equation 4 and Table 2). Huang et al also discloses rotating a crucible **2** (col 1, ln 20-60)

Huang et al teaches controlling the partial pressure of oxygen in the atmosphere to reduce the diffusion of oxygen from the melt to the atmosphere (col 5, ln 30-50), but Huang et al is silent to controlling the partial pressure of oxygen so at to inhibit Marangoni convection occurring in the semiconductor melt. Huang et al also teaches controlling the oxygen partial pressure to maintain a constant oxygen concentration in the upper layer of melt (col 7, ln 5-25) and controlling the evaporation rate of a Group V element (col 3, ln 15-25). Huang et al teaches a similar method of controlling the amount of oxygen diffusing from the melt, as applicant, therefore a Marangoni convection occurring in the melt is inherently inhibited. Furthermore, surface tension gradients, which cause Marangoni convection, will inherently be reduced because diffusion of oxygen from the melt surface is reduced.

Referring to claim 3, Huang et al discloses a Si melt (col 4, ln 45-55).

Referring to claim 5, Huang et al discloses oxygen partial pressure is detected during the growth of the single crystal and changed to obtain a constant oxygen concentration in the upper layer of the melt, this reads on applicant's oxygen concentration is controlled on the interface between the crucible and the melt because Huang et al discloses controlling the oxygen concentration of the entire upper layer of the melt, which includes the region between the melt and the crucible.

Referring to claim 6-7, Huang et al oxygen partial pressure is detected during the growth of the single crystal and changed to obtain a constant oxygen concentration in the upper layer of the melt. Huang et al is silent to the oxygen partial pressure changes in a radial direction. It is well known in the art that oxygen concentration of the melt will be reduced more readily at the crucible wall because of the reaction of the oxygen in the silicon melt and a quartz crucible wall, note pg 1 of the instant application. Therefore, the oxygen partial pressure would have to inherently change in the radial direction because in order to maintain a constant oxygen concentration in the upper layer of the melt, the partial pressure of oxygen would inherently be greater in regions where the oxygen concentration is lower.

Referring to claim 8, Huang et al discloses argon (col 6, ln 55-67).

Referring to claim 9, Huang et al discloses an oxygen sensor **17** and changing the oxygen partial pressure (claim 4).

Referring to claim 11, Huang et al is silent a buoyancy convection other than the Marangoni convection is inhibited. This is inherent to Huang et al because Huang et al disclose rotating the crucible **2** (col 1, ln 30-40), which inherently provides rotation to the melt, and

providing a rotation to the melt is well known in the art to inhibit buoyancy convection, note page 2 of the instant application.

Referring to claim 12, Huang et al discloses a Czochralski method (col 1, ln 15-60).

4. Claims 1-9 and 11-14 are rejected under 35 U.S.C. 102(b) as being anticipated by Ownby et al (US 4,400,232).

Ownby et al discloses oxygen related defects occur in the production of single crystal silicon from molten silicon (i.e. claim 3), for example in the Czochralski or float zoning techniques and a process for carefully controlling the presence of oxygen defects in the production of silicon bodies (col 1, ln 15-65). Ownby et al also discloses oxygen and carbon related defects can be controlled and reduced through deliberate addition of an oxygen containing buffering gas to the silicon processing chamber and maintain the oxygen partial pressure, this is interpreted by the examiner to read on applicant's control of one specific element contained in the atmosphere, in the chamber atmosphere at a low defect production level, which is less than about 10^{-6} atmosphere (col 2, ln 1-67). Ownby et al also discloses inlet gases may be mixed with an inert carrier gas, for example argon. Ownby et al discloses a single crystal of silicon being pulled from a melt in a Czochralski furnace comprising a crucible containing a melt of elemental silicon **25** (col 3, ln 5-67 and col 4, ln 1-25), a partial pressure of oxygen sensor within a furnace chamber (col 5, ln 1-65), and controlling the flow ratios of admitted gases to control the partial pressure of oxygen (col 6, ln 5-60).

Ownby et al is silent to a inhibiting a Marangoni convection. However, this is inherent to Ownby et al because Ownby et al teach a similar method of controlling the oxygen partial pressure, as applicant.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang et al (US 5,524,574).

Huang et al discloses all of the limitations of claim 10, as discussed previously, except the oxygen partial pressure is not less tan 1.8 E (-5) MPa.

Huang et al teaches detecting reaction conditions of oxygen partial pressure and changing the reaction conditions to obtain a single crystal having an oxygen concentration within a narrow range (claim 4), this is a teaching that oxygen partial pressure is a result effective variable. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Huang et al by optimizing the oxygen partial pressure to obtain same by conducting routine experimentation of a result effective variable (MPEP 2144.05). Also note, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

7. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang et al (US 5,524,574) in view of Ownby et al (US 4,400,232).

Huang et al discloses all of the limitations of claim 14, as discussed previously, except Huang et al teaches a Czochralski process and does not teach a Floating Zone Method.

In a method of reducing defects in silicon boules, (col 1, ln 5-15) Ownby et al teaches the production of silicon using the Czochralski or floating zone techniques (col 30-40). Ownby et al also teaches controlling the presence of oxygen in a silicon processing chamber (col 1, ln 60-67 and col 2, ln 25-45). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Huang et al by using other methods of processing silicon taught by Ownby et al, which are equivalent to the Czochralski.

Response to Arguments

8. Applicant's arguments filed 3/13/2003 have been fully considered but they are not persuasive.

Applicant's argument that it is impossible to suppress the irregular temperature fluctuations in the melt in the cite reference (pg 4, first full paragraph) has been noted but has not been found persuasive. This is a mere allegation by applicant without factual basis.

In response to applicant's argument that increasing the oxygen partial pressure, the surface tension of the silicon melt can be reduced (pg 4, second full paragraph), the fact that applicant has recognized another advantage, which would flow naturally from following the

suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

In response to applicant's argument that Marangoni convection is depend on the oxygen partial pressure (pg 6, First paragraph), the fact that applicant has recognized another advantage, which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). Huang et al discloses controlling the oxygen partial pressure to obtain a constant oxygen concentration in the silicon melt. Inhibit the Marangoni convection is inherent to Huang et al because Huang et al teaches a similar method of controlling the oxygen partial, as applicant.

Applicant's argument that the Huang reference and the Ownby reference does not teach inhibiting the Marangoni convection occurring in the semiconductor melt (pg 6, second full paragraph) has been noted but has not been found persuasive. Ownby et al and Huang et al both teach a similar method of controlling the oxygen partial pressure, as applicant; therefore inhibiting the Marangoni convection is inherent to Ownby et al and Huang et al.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Davis et al (US 5,695,820) teaches the Marangoni flow occurs because of differences in surface tension (col 1, ln 1-67).

Holder (US 5,904,768) teaches increasing the pressure of a reaction chamber during growth of silicon rod with zero dislocations (Abstract).

Kawanishi et al (US 6,086,671) teaches using magnetic fields to suppress SiO_2 from melting out from a quartz crucible.

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the

organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
May 22, 2003

BENJAMIN L. UTECH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700